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ORIGINAL ARTICLE

Self-determined motivation, physical exercise and diet in obese children: A three-year follow-up study

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KEYWORDS
Autonomous motivation;
Self-Determination Theory;
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Abstract The present study's objective was to track long term (three years intervention and six months ''detraining'') the influence of an exercise program with or without diet on the motivation of sedentary obese children. The participants were 27 children (8-11 years), divided into two groups according to the program they followed. The G1 group followed a physical exercise program (three 90-minute sessions per week), and the G2 group this physical exercise program plus a low calorie diet. The participants' motivation to engage in exercise was measured using the Behavioural Regulation in Exercise Questionnaire-2. Both groups showed improvements in amotivation in the 3rd year and in the detraining period (in the G1 and G2, respectively) and in intrinsic regulation of exercise behaviour (in the G1 and G2, respectively). There were also differences between the two groups in external regulation in the intervention and detraining periods. This appears to be indicative of the appropriateness of long-term physical exercise to generate greater autonomous motivation, and hence changes towards healthy living habits that are stable in time.

PALABRAS CLAVE
Motivación autónoma;
Teoría de la Auto-Determinación;
obesidad;
niños;
cuasi-experimento

Motivación autodeterminada, ejercicio físico y dieta en niños obesos: un estudio de seguimiento a tres años

Resumen El objetivo del presente estudio fue realizar un seguimiento a largo plazo (tres años y seis meses de intervención ''desentrenamiento'') sobre la influencia de un programa de ejercicio físico con o sin dieta sobre la motivación de los niños obesos sedentarios. Los participantes fueron 27 niños (8-11 años), divididos en dos grupos. El grupo G1 siguió un programa de ejercicio físico (tres sesiones de 90 minutos por semana) y el grupo G2siguió este programa de ejercicio físico más una dieta baja en calorías. La motivación de los participantes para participar en el ejercicio se midió usando el Cuestionario de Regulación de la Conducta en el Ejercicio

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Físico-2. Ambos grupos mostraron mejoras en la desmotivación en el tercer año y en el período de desentrenamiento (en los grupos G1 y G2, respectivamente) y en la regulación intrínseca de comportamiento de ejercicio (en los grupos G1 y G2, respectivamente). Esto parece ser indicativo de la idoneidad del ejercicio físico a largo plazo para generar una mayor motivación autónomay por, lo tanto, los cambios hacia hábitos de vida saludables son más estables en el tiempo.

The prevalence of childhood obesity has increased substantially over the past three decades worldwide (Han, Lawlor, & Kimm, 2010). Using the obesity criterion of the International Obesity Task Force, it is estimated that the global prevalence of obesity in children and youngsters (5-17 years) is approximately 3.2%, and in Europe it reaches 4% (Lobstein, Baur, & Uauy, 2004). Recommendations for the treatment of childhood obesity focus on lifestyle changes, including increased physical activity (PA) and the promotion of healthy eating habits (Han et al., 2010). Thus, the World Health Organization recommends that individuals in this age group should accumulate at least 60 minutes daily of mainly moderate or vigorous aerobic PA, and at least three times a week perform activities that develop locomotor strength (World Health Organization [WHO], 2010). However, the international Health Behaviour in School-Aged Children study (WHO, 2010) indicates that only 27% of girls and 40% of boys meet these PA recommendations.

Obese children are less physically active than their leaner peers (Deforche, De Bourdeaudhuij, D'hondt, & Cardon, 2009). It remains unclear why overweight or obese individuals are less willing than normal weight ones to be involved in physical activity (Hwang & Kim, 2011). Studies in this regard indicate the benefits of physical activity and exercise in this population (Escalante, Saavedra, García-Hermoso, & Dominguez, 2012; García-Hermoso, Saavedra, & Escalante, 2013; Saavedra, Escalante, & García-Hermoso, 2011). Thus, interventions of an aerobic nature (3 sessions of 60 minutes weekly) seem to generate changes in aerobic fitness (Saavedra et al., 2011), lipid profile–mainly in LDL and TG (Escalante et al., 2012), and resting blood pressure (García-Hermoso et al., 2013).

Self-Determination Theory (SDT) has been used to identify relationships between the initiation of physical activity, adherence to it, and the psychological variables influencing obese children (Deforche, De Bourdeaudhuij, & Tanghe, 2006). Understanding these relationships is important in designing strategies for the promotion of physical activity to prevent weight gain and to treat obesity among adolescents (Hwang & Kim, 2011). In this regard, there has been extensive application of SDT approaches in research in the field of obesity and physical activity (Hwang & Kim, 2011; Verloigne et al., 2011). These studies indicate that obese children with high levels of intrinsic motivation have greater adherence to physical exercise programs designed to lose weight compared with their counterparts with low levels of such motivation (Hwang & Kim, 2011; Verloigne et al., 2011). Likewise, overweight and obese adolescents present higher scores on demotivation and extrinsic motivation, but lower scores on intrinsic motivation than their normal weight counterparts (Hwang & Kim, 2011). Since specific treatment programs are needed to address obesity, it is interesting to analyse how they might impact the different types of motivation towards physical activity. It seems that children's obesity treatment programs can increase autonomous forms of motivation towards PA during treatment, provided that particular attention is paid to autonomy, competence, and relatedness (Verloigne et al., 2011). Such treatments should, in as far as possible, try to minimize control (Verloigne et al., 2011) and offer activities that are fun and attractive (Deforche et al., 2006). In the management of overweight, it is essential to make a particular effort to increase physical activity adherence (Annesi & Johnson, 2013; Deforche, Haerens, & De Bourdeaudhuij, 2011). However, these treatments (in particular, residential treatments) appear to exert pressure on obese individuals to carry out physical activity and lose weight, and, if one accepts the assumptions of SDT, this could negatively impact their autonomous motivation (Verloigne et al., 2011). Indeed, reducing motivation to its quantitative dimension could be a major limiting factor in current weight loss interventions (Teixeira, Silva, Mata, Palmeira, & Markland, 2012). It therefore seems necessary to determine whether longitudinal interventions foster greater motivation, and if so, whether this motivation is maintained over time (Hwang & Kim, 2011), promoting healthy lifestyles in obese children. The objective of the present study was therefore to track long term (three years intervention and six months ''detraining'') the influence of an exercise program with or without diet on the motivation of sedentary obese children.

Method

Participants

A total of 135 subjects were invited to participate through the collaboration of various schools in the town of Cáceres (Spain). The inclusion criteria were: (i) a body mass index (BMI) equal to or greater than the 97th percentile for the age and sex of the subject; (ii) age between 8 and 11 years as defined by Spanish population curves (Hernández et al., 1988). Subjects were excluded if they were: (i) regularly practising PA, or following an exercise program or some other therapy ($n = 65$); (ii) involved in any weight control program ($n = 18$); (iii) were taking any medication ($n = 8$); (iv) had any type of dysfunction limiting their physical activity ($n = 2$); other reasons ($n = 9$). The final sample comprised 27

Caucasian sedentary children (10.4 ± 1.0 years). They were divided into two groups: the G1 group who followed a multi-sports exercise program (n = 11: 8 boys and 3 girls), and the G2 group who followed a combination of two programs—the above exercise program plus a low calorie diet (n = 16: 10 boys and 6 girls). Table 1 presents the characteristics of the G1 and G2 groups. All the children's parents completed a prior informed consent form. The study was approved by the Bioethics and Biosecurity Committee of the Universidad of Extremadura (Spain) and respected the principles of the Declaration of Helsinki.

Interventions

Exercise program

The exercise program was carried out in a multi-sports hall, supervised by two MSc's in Sports Sciences (AGH and AMD), and under the overall supervision of two PhD's in Sports Sciences (JMS and YE). The program consisted of three weekly 90-minute sessions. Each session comprised a warm-up (15-20 min), a main part consisting of pre-sports and multi-sports games with a moderate to vigorous intensity aerobic component (60-65 min), and a cool-down (5-10 min). In so far as possible, we respected the sporting interests and tastes of the research subjects, giving them different activities per session to choose from, encouraging cooperative activities and interpersonal relationships. Compliance was assessed as percentage of exercise sessions attended, and resulted to be good, with the children attending more than 78% of the total exercise sessions (230 sessions).

Diet program

The low-calorie diet consisted of five balanced meals spread throughout the day, with an energy intake of 1,500 kcal/day. In this sense, there have been studies that recommend diets of between 1,500 and 1,800 kcal/day in obese children who are still growing, since in this way their growth and development are not compromised (Epstein, Myers, Raynor, & Saelens, 1998). It consisted of 57% carbohydrates, 17% proteins, and 26% fats. Foods were selected according to the subject's dietary habits. A series of general recommendations were established focused on basic healthy lifestyle eating: consume ≥ 5 servings of fruits and vegetables every day; minimize sugar-sweetened beverages such as soft drinks, sports drinks, and sugar-added fruit juices; have more meals prepared at home rather than purchasing take-away restaurant food; etc. Regular meetings were held with the children's parents to control and monitor the diet.

Measures

Each subject was evaluated for the following parameters: eating habits, daily physical activity, pubertal status, kinanthropometry, and motivation. The evaluations were made at the start (baseline), and at 31 (3rd-year intervention) and 37 months (6 months detraining) into the program. The eating habits questionnaire together with instructions for completing was handed out during the physical exercise program of Thursday and collected in during the following Monday session. To evaluate the daily physical activity, the accelerometers were distributed during Wednesday's exercise session, and collected in during the following Monday session. On that same day (Monday), pubertal status, kinanthropometry, and motivation were evaluated.

Eating habits

Nutrition was assessed with a self-reported 3-day food record (2 weekdays and 1 weekend day in succession, i.e., Thursday, Friday, Saturday) filled in by the parents. The weight of the food was estimated from the parents' records. A computerized database [deleted for blinding purposes] was used to calculate the daily intake [deleted reference for blinding purposes], and the program logged the mean of the three days (kcal/day).

Daily PA

Daily PA was measured before the intervention, during the follow-up, and at the end of detraining, using a validated uniaxial accelerometer (Caltrac), and covering a 3-day period (Thursday, Friday, and Saturday) except during bathing and swimming. All participants were instructed to record the amount of time spent cycling or swimming during the evaluation period. At the beginning and the end of the day, the subjects recorded the number of ''motion counts'' of the accelerometer, following previously published protocols (Sallis, Buono, Roby, Carlson, & Nelson, 1990). The final Caltrac score was recorded, as also was the average of the three days (motion counts per day).

Table 1 Characteristics of the total sample.

	G1 ($M \pm SD$)	G2 ($M \pm SD$)	F	p
Age	10.7 ± 0.90	10.1 ± 1.02	2.63	.085
Tanner stage (pubic hair)	2.0 ± 0.63	1.81 ± 0.54	0.06	.796
Eating habits (kcal/day)	1912.9 ± 204.10	1906.2 ± 210.90	0.01	.897
Height (m)	1.49 ± .10	1.46 ± 0.10	0.53	.473
Weight (kg)	62.1 ± 9.86	57.6 ± 11.20	0.25	.617
BMI (kg/m^2)	27.8 ± 3.42	27.3 ± 3.88	0.50	.483
BMI z-score	3.52 ± 3.72	2.76 ± 3.56	0.28	.597
Fat mass (%)	25.4 ± 6.90	25.8 ± 5.70	0.37	.545
Fat free mass (kg)	38.1 ± 7.45	39.3 ± 6.99	0.03	.815

Note. G1= exercise group, G2 = exercise plus diet group.

The accelerometer used (Hemokinetics, Madison, WI, USA) was programmed to function as a physical activity monitor (Sallis et al., 1990). It contains a piezoelectric bender element which assesses the intensity of movement in the vertical plane. Its validity has been demonstrated as a method for estimating energy expenditure in children (Maliszewski, Freedson, Ebbeling, Crussemeyer, & Kastango, 1991), and it has been used in other studies (Raudsepp & Päll, 2006; Sallis et al., 1990). Although it does not record such activities as rowing or swimming, no activities of these kinds were used in the subjects' daily physical activity for the duration of the study.

Pubertal status and kinanthropometry

Pubertal stage was evaluated by a trained pædiatrician according to pubic hair development using the Tanner classification criteria (Tanner, Whitehouse, & Takaishi, 1966). The kinanthropometric measurements followed the ISAK protocol (Norton et al., 1996): body height, body weight, body fat mass, and fat free mass (bio-impedance). Standard equipment was used: a scale-mounted stadiometer (Seca, Berlin, Germany), a weight scale (Seca, Berlin, Germany), and a bio-impedance analyser (Bodystat 1500, Bodystat Ltd, Douglas, Isle of Man, UK). BMI was calculated as weight divided by height squared (kg/m^2), and the status ponderal (BMI z-score) were determined [deleted reference for blinding purposes].

Motivational regulations for exercise

The participants' motivation to engage in exercise was measured using the 19-item Behavioural Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004) in its form validated for the Spanish context (Moreno, Gimeno, & Camacho, 2007). The BREQ-2 consists of 19 items divided into 5 subscales (1 = not true for me, 5 = very true for me), one measuring amotivation (four items; e.g., ''I think exercising is a waste of time'), and four measuring forms of regulation of exercise behaviour: external (four items; e.g., ''I am physically active because I feel under pressure from my friends/family to exercise''), introjected (three items; e.g., ''I feel ashamed when I miss an exercise session''), identified (four items; e.g., ''I am physically active because it's important to me to exercise regularly''), and intrinsic (four items; e.g., ''I am physically active because I enjoy my exercise sessions''). The test-retest Cronbach's α reliability coefficients for this Spanish version of the BREQ-2 subscales range from .81 to .89 (Moreno et al., 2007), and the questionnaire has also been specifically validated for use in obese pædiatric populations (Verloigne et al., 2011).

Data analysis

The present intervention it is a quasi-experimental study (Hartley, 2012; Ramos-Álvarez, Moreno-Fernández, Valdés-Conroy, & Catena, 2008). All the variables satisfied the tests of homoskedasticity (Levene variance homogeneity test) and normality (Kolmogorov-Smirnov test) of their distributions. The basic descriptive statistics (means and standard deviations) were calculated. A repeated-measure ANOVA was used to compare the interaction between the different groups (G1 and G2 group) and the different evaluations (baseline, 3rd-year, and detraining), and another ANOVA was applied to compare the differences between the three evaluations. The Tukey post hoc test was used to compare means. Cohen's categories were used for the magnitudes of the effect size (ES): small if $0 \leq |d| \leq .2$; medium if $.2 < |d| \leq .5$; and large if $|d| > .5$ (Cohen, 1988). Obese prevalence was compared using Pearson's χ^2. The level of significance for all statistical tests was set at $p \leq .05$. All calculations were performed using SPSS (version 16.0).

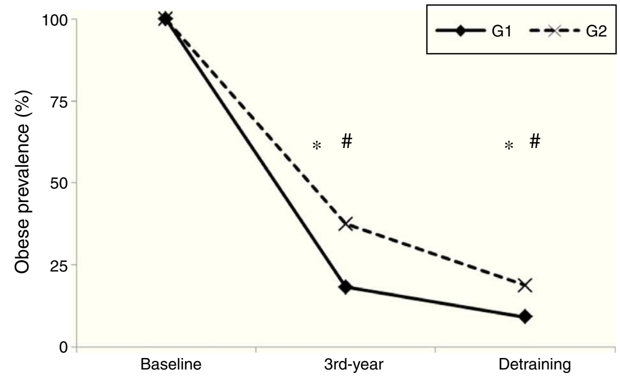

Figure 1 Changes ponderal status at the baseline, third year, and detraining evaluations in obese children. Obese prevalence: *$p < .05$ in the G1 group; #$p < .05$ in the G2 group.

Results

Table 2 presents the changes in the 5 motivation parameters and in the daily PA at the different times of evaluation (baseline, 3rd-year, and detraining) in the G1 and G2groups. Regarding intragroup differences, in both groups there were longitudinal changes from baseline to the 3rd year in amotivation (G1 group, $p = .001$, ES = -1.52; G2 group, $p < .001$, ES = -3.15), and in intrinsic regulation (G1 group, $p < .001$, ES = 2.78; G2 group, $p < .001$, ES = 2.04). Similarly, there were changes relative to baseline in these same two parameters in the detraining period: in amotivation (G1 group, $p = .001$, ES = -1.96; G2 group, $p < .001$; ES = -3.10), and in intrinsic regulation (G1 group, $p < .001$, ES = 2.70, G2 group, $p < .001$, ES = 3.00). Lastly, the daily physical activity of the subjects in both groups had increased in the detraining period. Furthermore, there were changes in obese prevalence in both groups in and periods ($p < .05$) (Figure 1). Regarding the intergroup differences, there were differences between the two groups in external regulation in the 3rd year of the intervention and in the detraining period (G1 < G2).

Discussion

To the best of our knowledge, this has been the first longitudinal (three years duration) study to analyse the effects of programs of exercise and/or diet on the motivation of obese subjects. The results indicate that such long-term longitudinal intervention consisting of exercise programs both with and without a diet, as determined both near the end of

Table 2 Mean and standard deviation in motivation and daily physical activity parameters at the baseline, 3rd year, and detraining evaluations in obese children. The effects size (ES) was calculated only when $p < .05$.

Group	Intervention time		Detraining time	ANOVA			Effect size (Cohen' *d*)		
	Baseline Mean ± *SD* a	3-year Mean ± *SD* b	6 months Mean ± *SD* c	*df*	*F*	*p*	a-b	a-c	b-c
Amotivation									
G1	3.18 ± 1.25	1.57 ± 0.79	1.29 ± 0.49	10	10.17	.001	-1.48	-1.87	-
G2	3.41 ± 1.05	1.03 ± 0.09	1.06 ± 0.11	15	38.53	< .001	-2.98	-2.93	-
p	.618	.075	.230						
ES (d)	-	-	-						
External regulation									
G1	2.00 ± 1.02	1.53 ± 1.04	1.56 ± 1.05	10	0.21	.807	-	-	-
G2	2.48 ± 1.15	2.75 ± 0.84	2.75 ± 0.98	15	0.77	.472	-	-	-
p	.269	.028	.042						
ES (d)	-	1.31	1.18						
Introjected regulation									
G1	3.36 ± 0.70	2.86 ± 0.70	3.00 ± 0.82	10	1.14	.337	-	-	-
G2	3.31 ± 0.93	3.03 ± 0.76	3.53 ± 0.51	15	0.77	.469	-	-	-
p	.878	.655	.148						
ES (d)	-	-	-						
Identified regulation									
G1	4.67 ± 0.65	4.23 ± 0.81	4.31 ± 0.81	10	0.88	.429	-	-	-
G2	4.60 ± 0.55	4.50 ± 0.54	4.60 ± 0.53	15	0.11	.894	-	-	-
p	.793	.468	.415						
ES (d)	-	-	-						
Intrinsic regulation									
G1	2.18 ± 1.08	4.53 ± 0.47	4.50 ± 0.52	10	25.39	< .001	2.67	2.60	-
G2	2.20 ± 1.21	4.22 ± 0.67	4.87 ± 0.27	15	19.57	< .001	1.99	2.85	-
p	.963	.316	.096						
ES (d)	-	-	-						
Daily PA									
G1	443.7 ± 106.8	611.7 ± 159.9	724.4 ± 124.2	10	10.18	.001	1.27	2.45	
G2	442.7 ± 99.7	526.1 ± 120.7	771.1 ± 91.5	15	23.96	< .001	4.44	7.56	
p	.981	.259	.439						
ES (d)	-	-	-						

Note. G1= exercise group, G2 = exercise plus diet group. Cohen's categories were used for the magnitudes of the effect size (ES): small if $0 \leq |d| \leq 0.2$; medium if $0.2 < |d| \leq 0.5$; and large if $|d| > 0.5$ (Cohen, 1988).

the intervention and in the corresponding detraining period, reduces amotivation and increases intrinsic regulation of these obese subjects. Differences between the two groups (with and without diet) were observed only in external regulation (in the 3rd year and in the detraining period).

Intra-group differences

There were reductions in amotivation from the baseline in both groups: in the 3rd year in the G1 (ES = -1.52) and the G2 group (ES = -3.15), and in detraining in the G1 (ES = -1.96) and in the G2 group (ES = -3.10). These results contrast with a recent study which found no change over time in amotivation after a 10-month multi-component exercise and diet program based on SDT (Verloigne et al., 2011). This might indicate that long-term intervention is required to generate changes in this motivational parameter. Similarly, it has been shown that residential treatment programs might have put pressure on the children to become physically active (Markland & Ingledew, 2007), which could have led to there being no decrease in amotivation in the medium term. Thus, one study concludes that, although obese adolescents may perceive losing weight as an important benefit of being physically active (''feeling or looking better'', and ''improving health and physical condition''), this might not encourage continued participation in physical activity programs (Deforche et al., 2006). Probably, as the results of the present study suggest, more time is needed for obese children to perceive exercise and balanced diet as habits of a healthy lifestyle (Reinehr, Kleber, Lass, & Toschke, 2010).

Similarly, changes were observed in intrinsic regulation in both groups: in the 3rd year of the intervention in the G1 (ES = 2.78) and in the G2 group (ES = 2.04), and in detraining in the G1 (ES = 2.70) and in the G2 group (ES = 3.00). Unlike the case of the previous parameter (amotivation) however, the present study confirms the findings of the aforementioned multi-component program of exercise and diet in the medium term (Verloigne et al., 2011). It seems that this combined procedure is effective at positively changing obese subjects' intrinsic motivation in the long term. Similar results were observed with interventions of physical exercise alone. According to SDT, long-term participation is likely to be sustained by intrinsic, but not by extrinsic, motives (Deci & Ryan, 1985). This is reflected in the maintenance of this intrinsic motivation in the detraining period, with an increase in physical activity of the subjects compared to their baseline (Table 2). These findings could be explained by a lower perceived barrier to physical activity (Deforche et al., 2011). After several years of multisport exercise, the subjects have a more positive attitude, possibly practising some physical activity at which they feel competent (Craig, Goldberg, & Dietz, 1996). This highlights the importance of activities that are pleasurable and generate satisfaction when they are carried out (Hwang & Kim, 2011; Silva et al., 2010; Verloigne et al., 2011).

Intergroup differences

There was greater external motivation in the G2 group than in the G1 group in both the 3rd year of the long-term intervention (ES = -1.27) and in the detraining period (ES = -1.14) (Table 2). Despite the absence of long-term changes (intragroup differences) in this parameter, it appears that external regulations were more important motivating factors towards PA in the subjects who were following a low calorie diet. This may be because this group perceives a context that is oriented towards weight loss (Silva, Capurro, Paz, & Slachevsky, 2013; Verloigne et al., 2011), even though that context also includes a physical exercise program. This intervention would thus have ignored certain important aspects in the adoption of new behaviours (e.g., developing an interest in physical exercise or personal meaning in changing one's diet for good) (Teixeira et al., 2012). The results of a recent study of obese adolescents indicate that a strictly controlled environment could have engendered increases in controlled forms of motivation (Verloigne et al., 2011). In particular, it seems advisable to minimize the impact of weight control (Hwang & Kim, 2011; Markland & Tobin, 2004). Nevertheless, both amotivation and intrinsic regulations are positively related to external motivation (Thøgersen-Ntoumani & Ntoumanis, 2006).

The practical strategies for this population need to be designed to foster internal motivation towards greater participation in physical activity (Hwang & Kim, 2011). In this regard, a recent study finds that if the needs of autonomy (i.e., having choices), competence (i.e., feeling effective), and relatedness (i.e., being socially connected) are met then there will be greater autonomous motivation towards physical activity in overweight/obese children (Deforche et al., 2011).

A number of limitations of this study need to be borne in mind. First, there was no initial randomization of the groups. Several subjects ate at the school's refectory, or were unable to attend the exercise program, making it impossible to randomly assign membership to one or another group. Nonetheless, the homogeneity of the groups was verified by the absence of initial differences in any of the variables (Table 1). Second, the number of subjects in the study was small (*n* = 27), although the study's longitudinal character could make this limitation of only relative importance.

In summary, the present study has applied SDT to attempt to understand the motivational processes related to physical exercise and diet in obese children. The results suggest that longitudinal exercise programs with or without diet lead to decreases in obese children's amotivation and increases in their intrinsic regulation of physical exercise behaviour, with the detraining period being followed by increased daily PA and decreased in obese prevalence. Although both interventions gave positive results, the combined program (exercise plus diet) gave higher scores on the externally motivated regulation for PA than the exercise intervention alone. In sum therefore, long-term physical exercise appears to be ideal for generating greater autonomous motivation, and hence modifications in healthy lifestyle habits that are stable over time.

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